



## Wind energy: Trends and development

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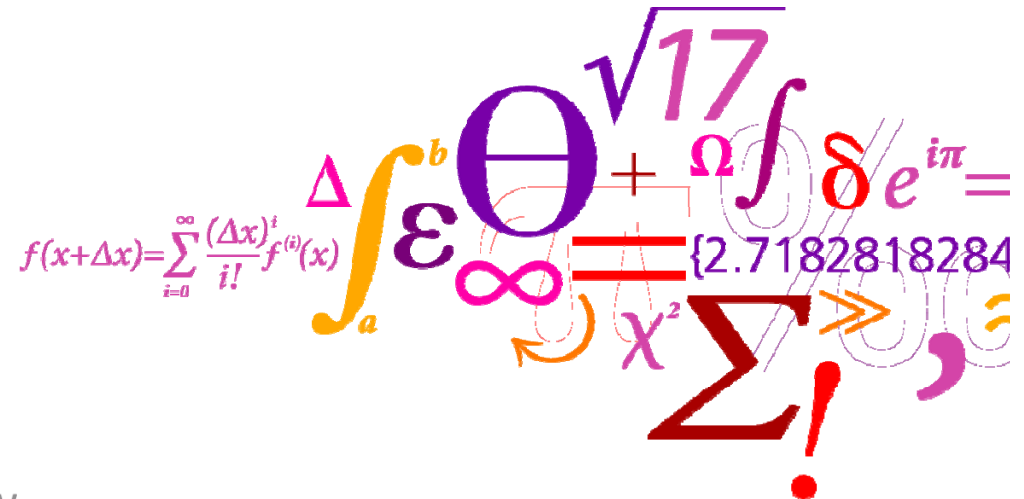
# Wind Energy: Trends and development

**Thomas Buhl** - Senior Scientist at Risø DTU

ESF-NSF Workshop  
Lyon October 15<sup>th</sup> to 17<sup>th</sup> 2008

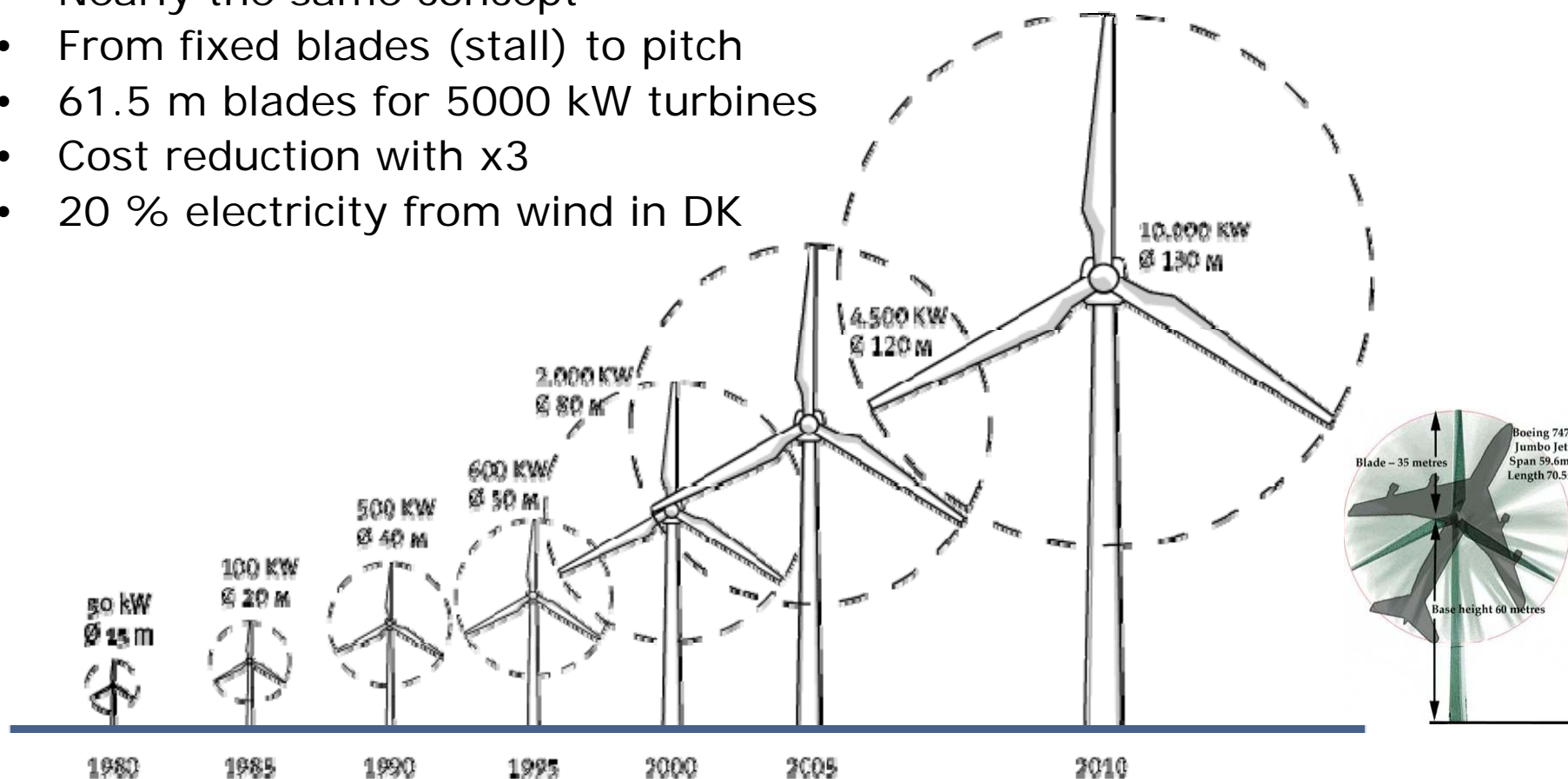
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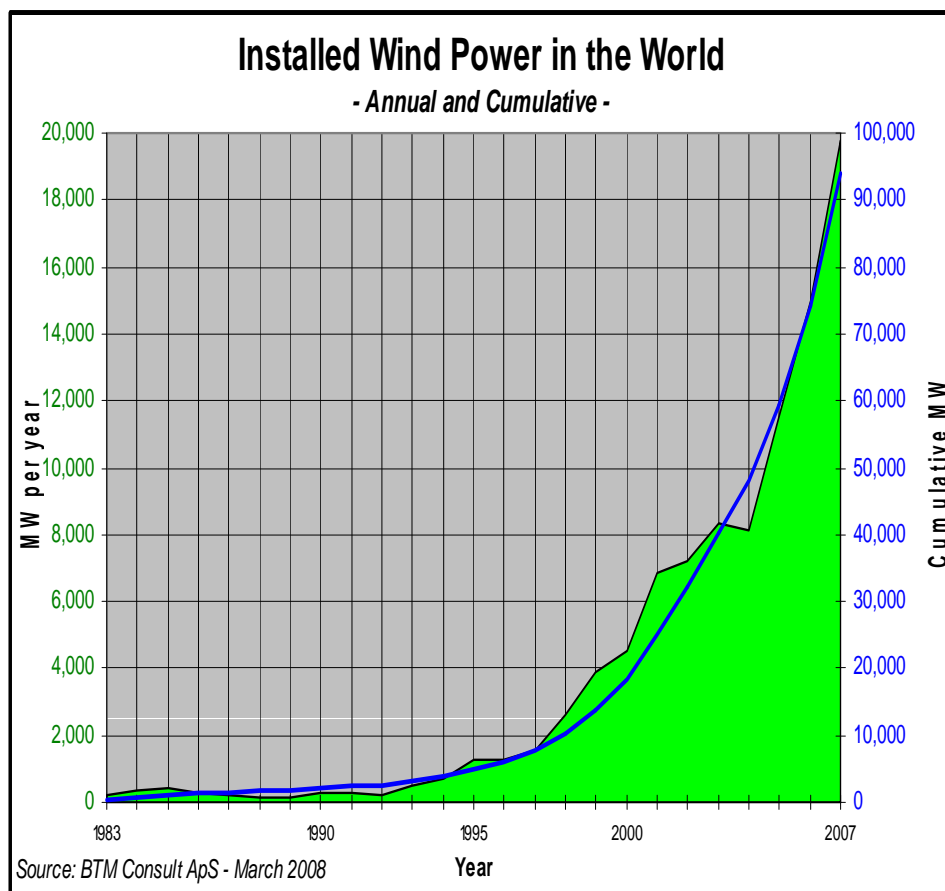


# Development

- Up-scaling by x100, from 50 to 5000 kW in 20 years
- Nearly the same concept
- From fixed blades (stall) to pitch
- 61.5 m blades for 5000 kW turbines
- Cost reduction with x3
- 20 % electricity from wind in DK



# World market



## GLOBAL STATUS

- **94 GW installed in total**
- **~1% offshore**
- **1.01 % of global electricity**
- **Wind power growing 27% per year**
- **Installed power doubles every 3 years**
- **Goal 2020: 12 %, 1200 GW**

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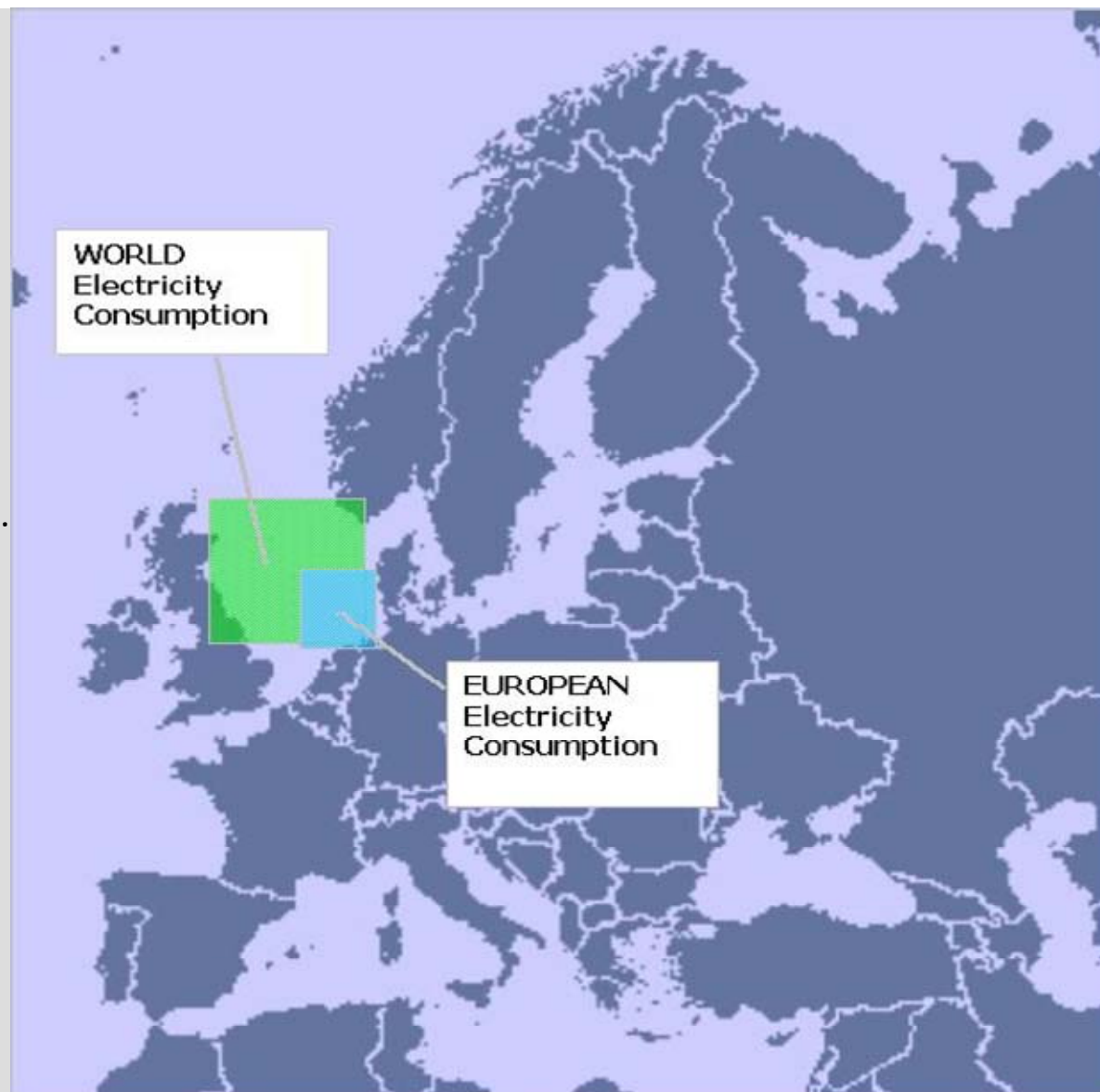
# Wind energy as base load

Integration is the challenge.

- Electric cars (V2G)
- Pumped storage

Norway:

- 25 GW Hydro power.
- ~2 GW pumped storage.
- Potentials for more



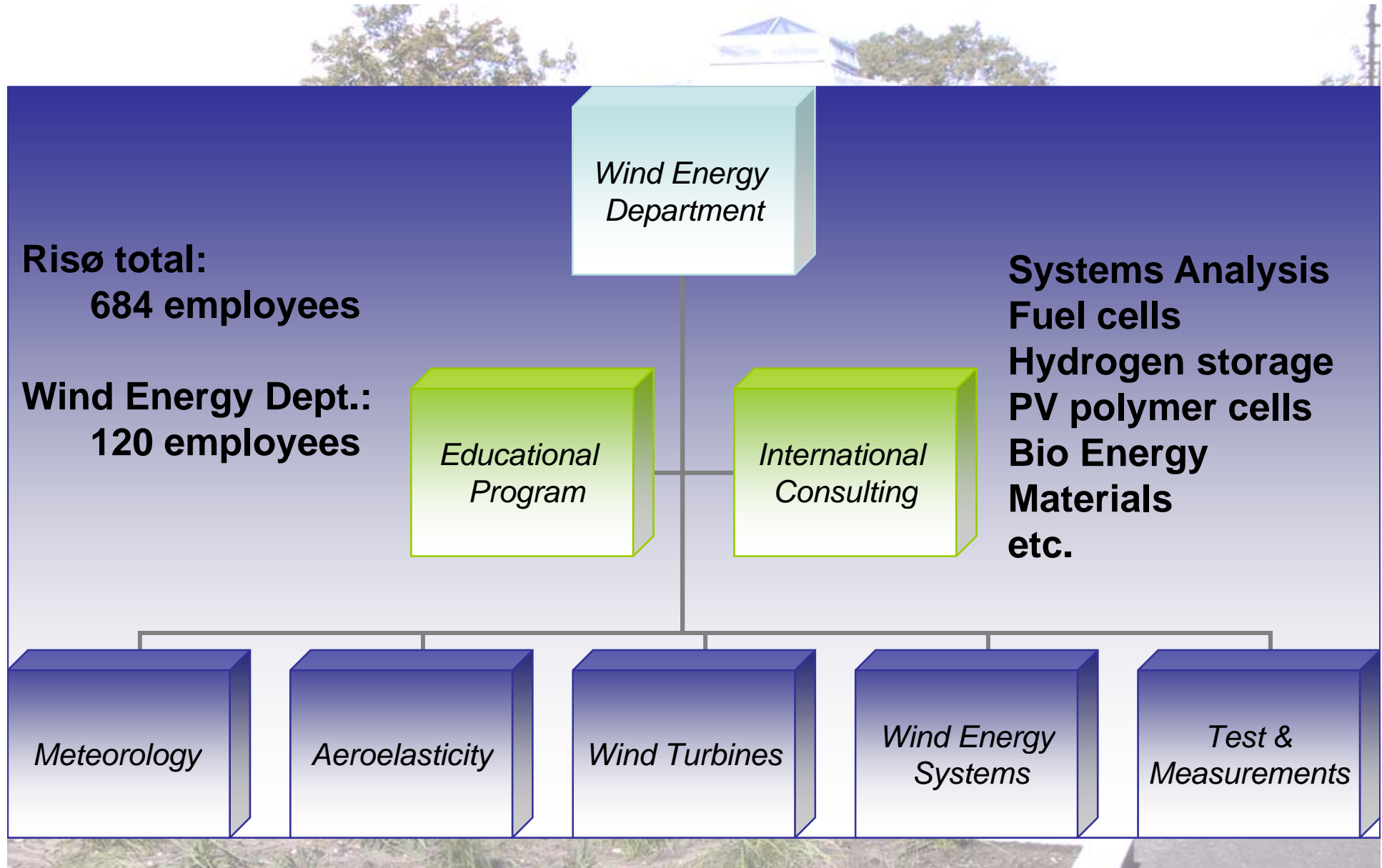
# Introduction to Risø DTU



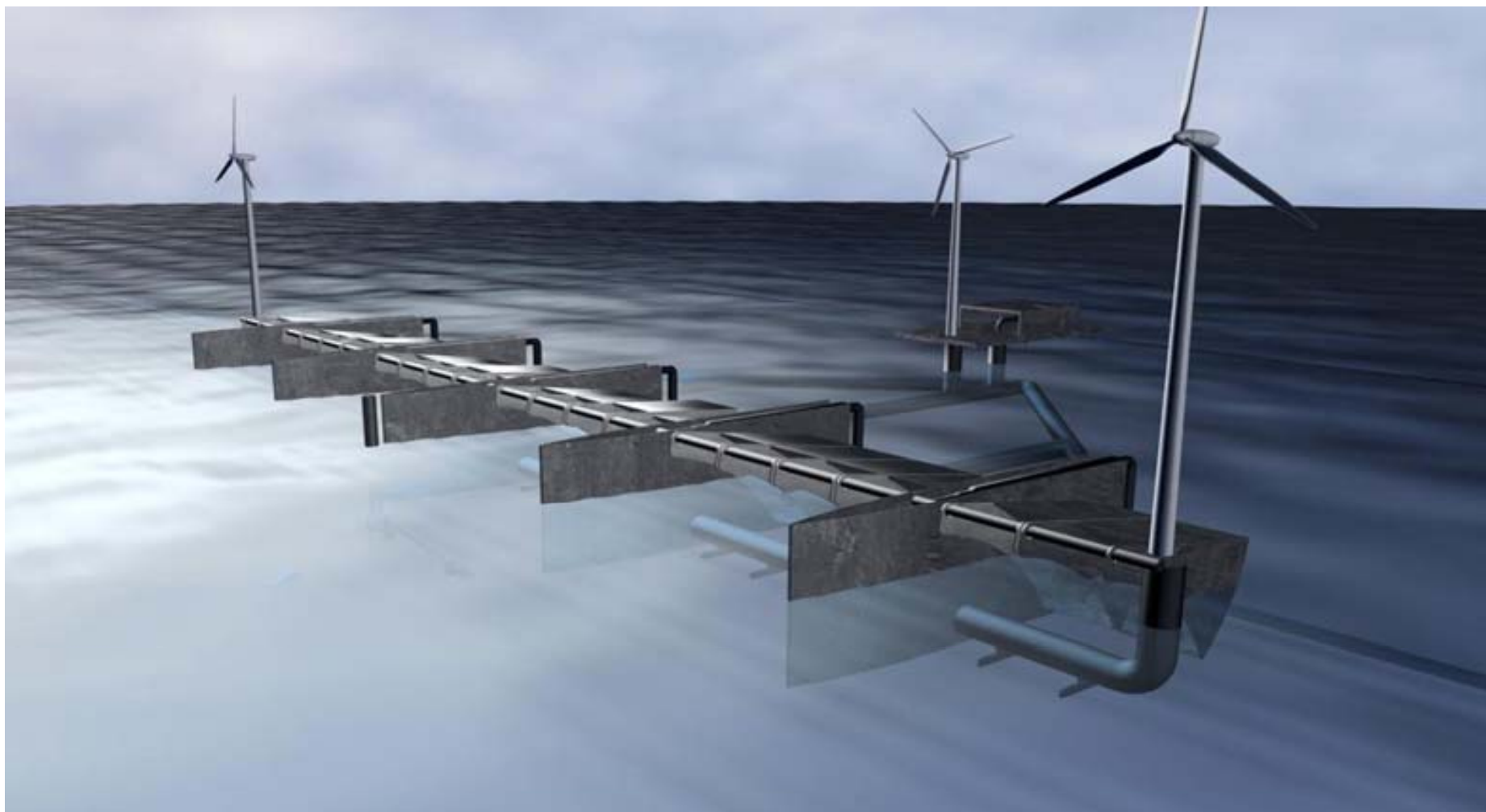
- **1958** Inaugurated. Purpose: Peaceful utilisation of nuclear energy
- **1976** Oil crises (1973) results in research in other Energy sources
- **1978** Research in Wind Energy starts
- **1985** Political decision of not having nuclear energy in Denmark
- **1994** State-owned enterprise
- **2000** The last nuclear reactor is shut down
- **2007** Merger with DTU, the Danish Institute for Food and Veterinary Research, the Danish Institute for Fisheries Research, the Danish National Space Centre and the Danish Transport Research Institute



# Introduction to Risø DTU



# Off shore development

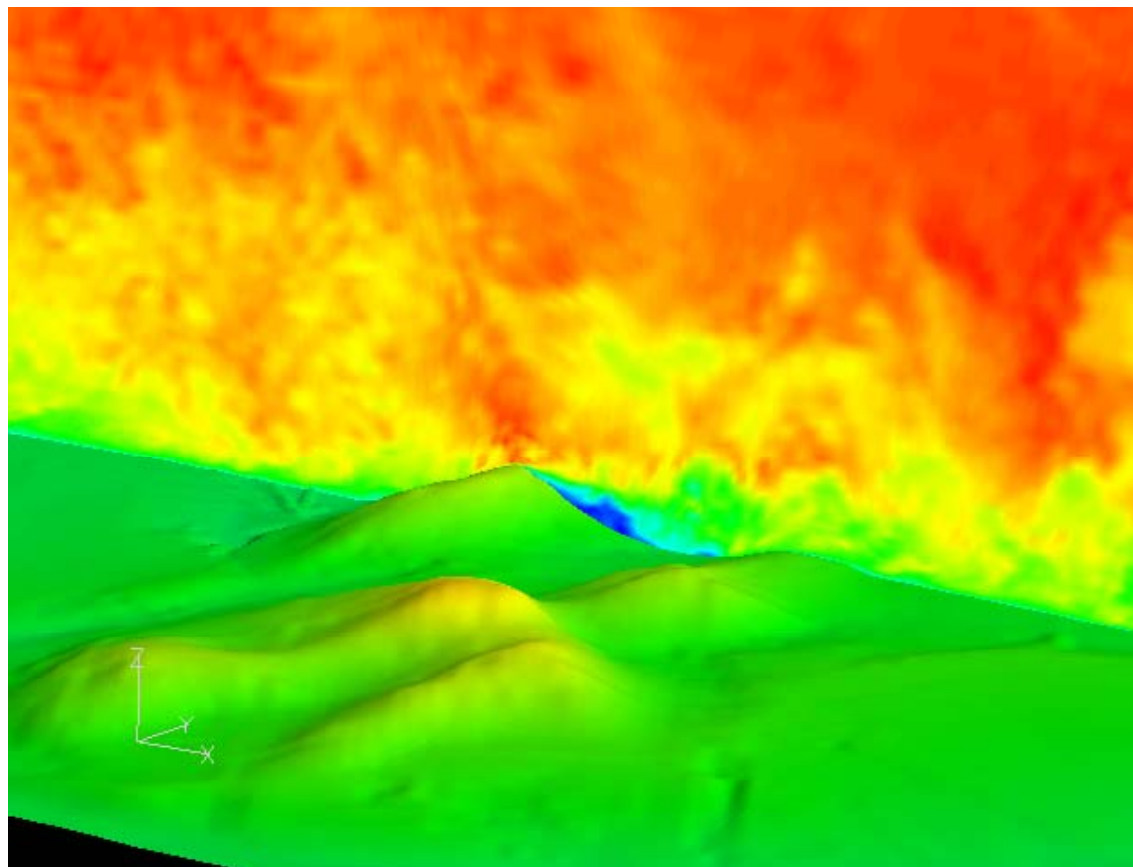


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# Problem



# Wake turbulence in wind farms



# Adaptive trailing edges

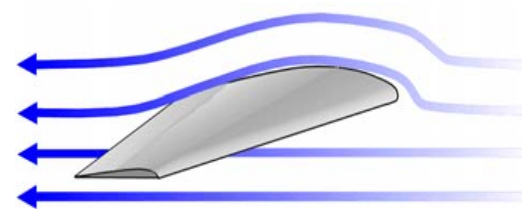
From 2003 to today:  
three large research projects  
involving more than 10 researchers,  
6 master thesis and 3 Ph.d's



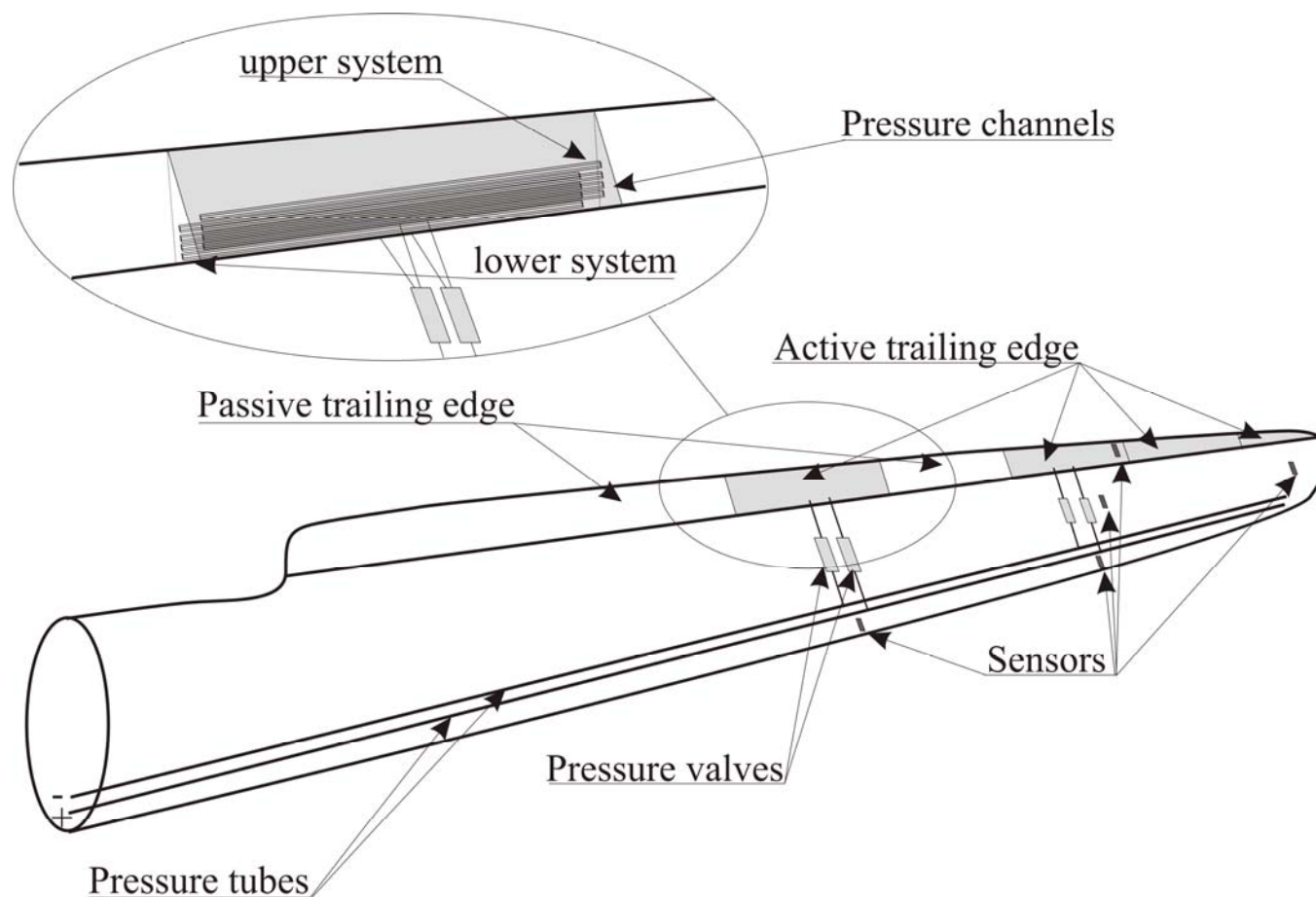
**Inspiration**



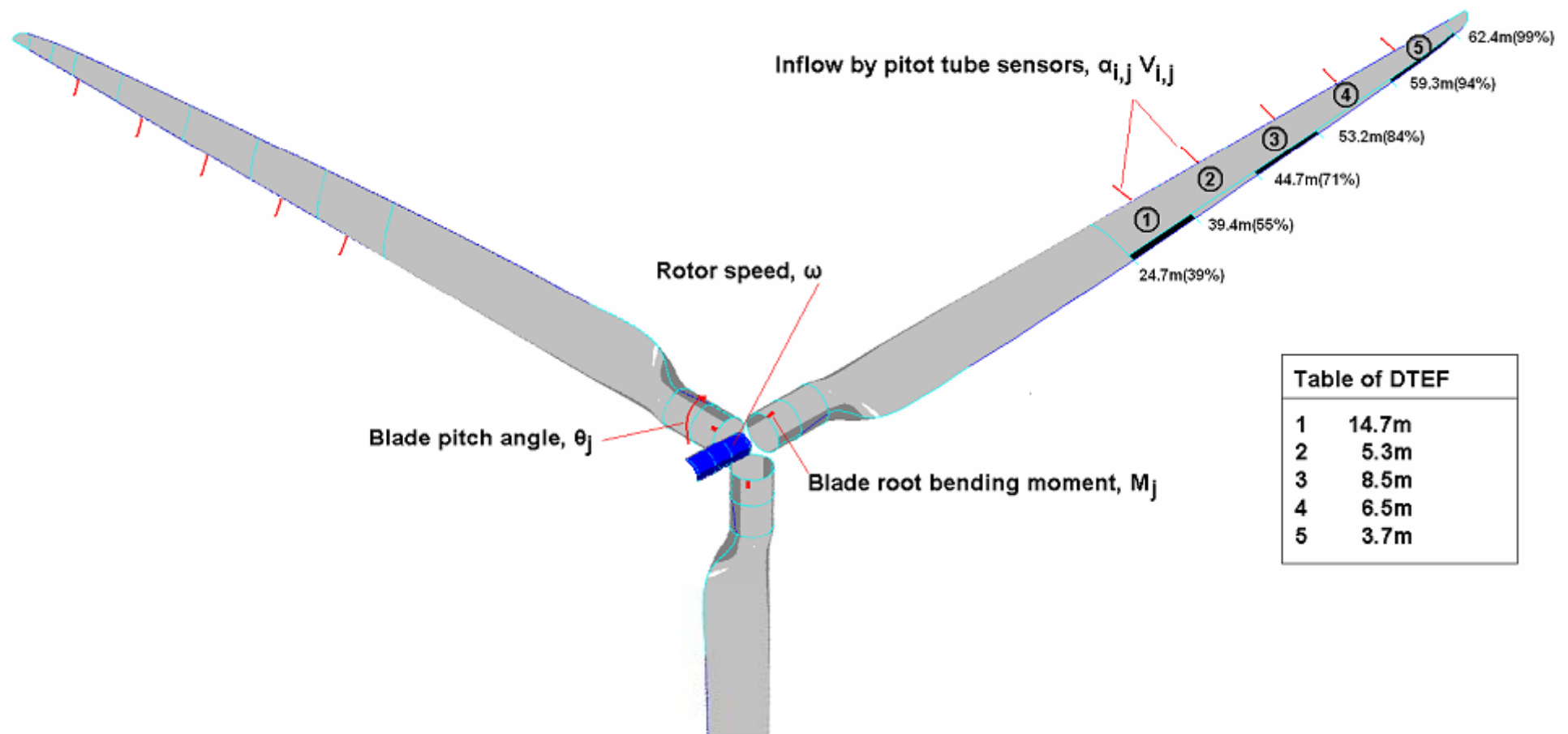
**Not applicable!**



# Typical layout

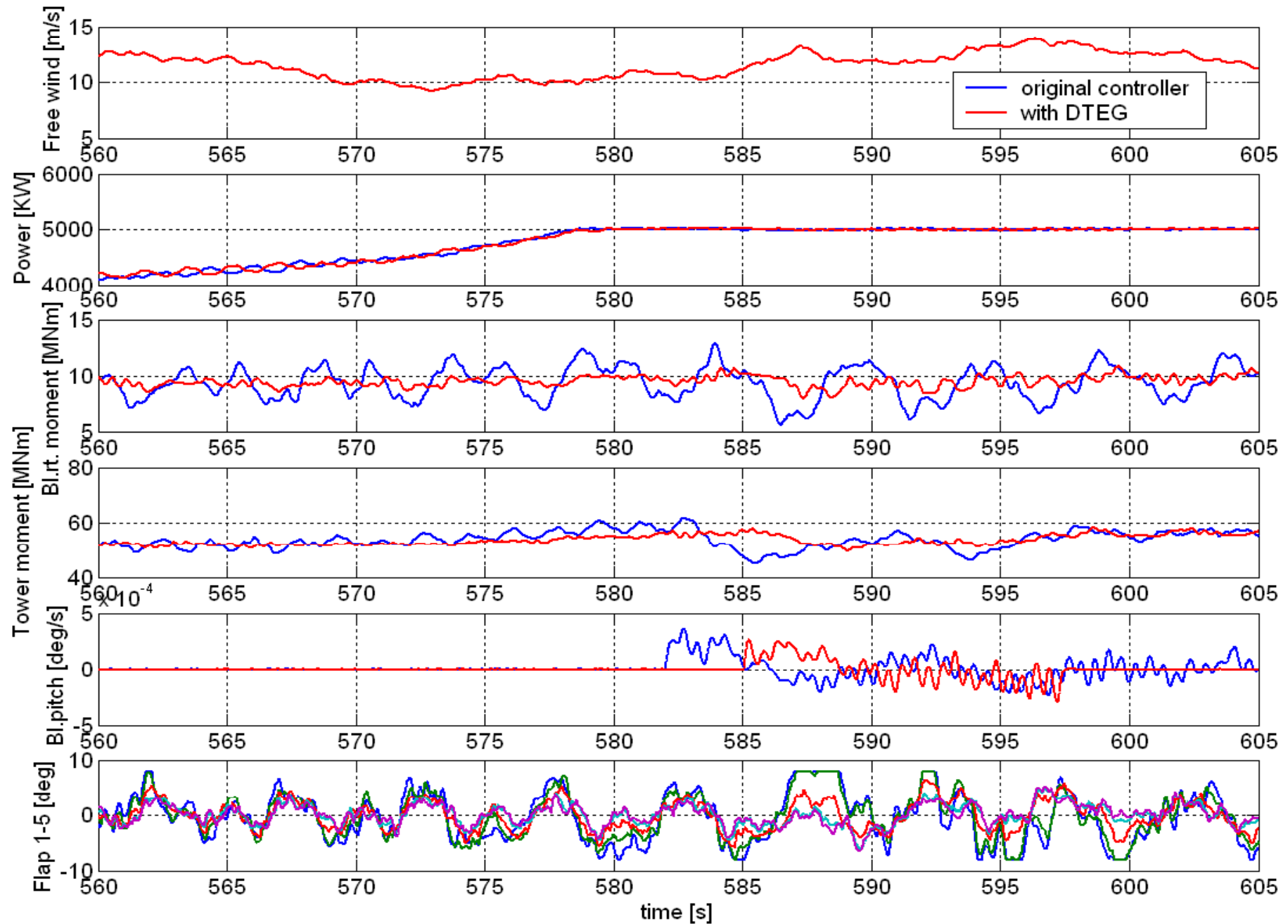


# Typical layout



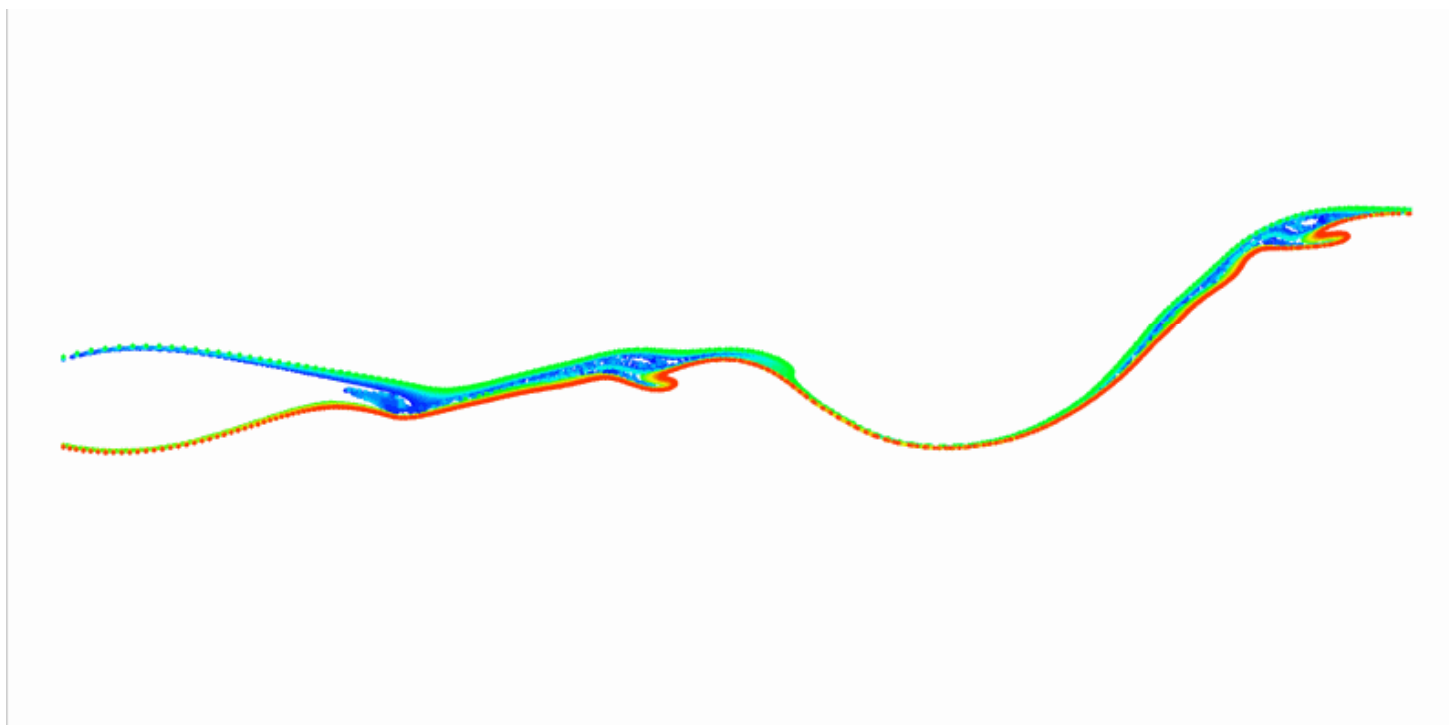


# Numerical results

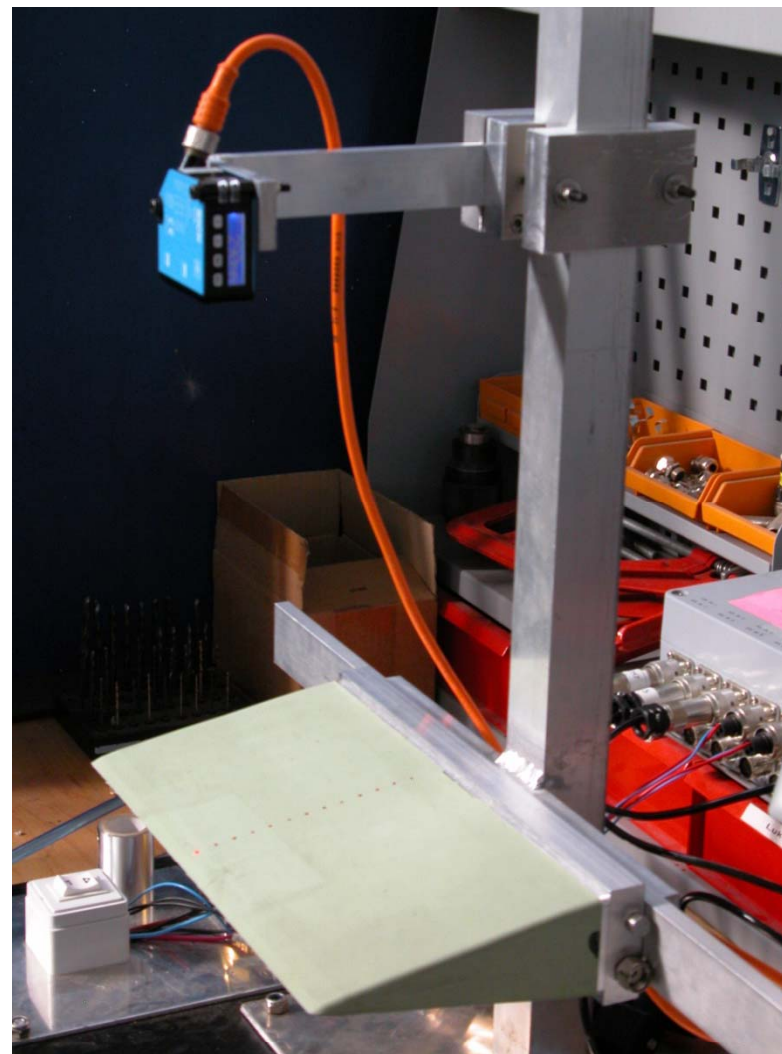
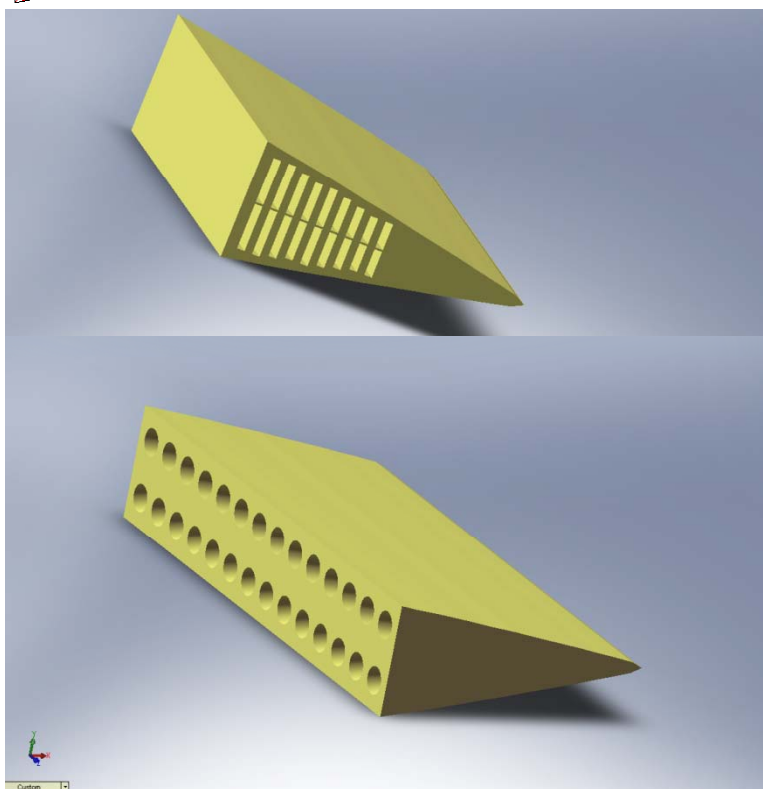
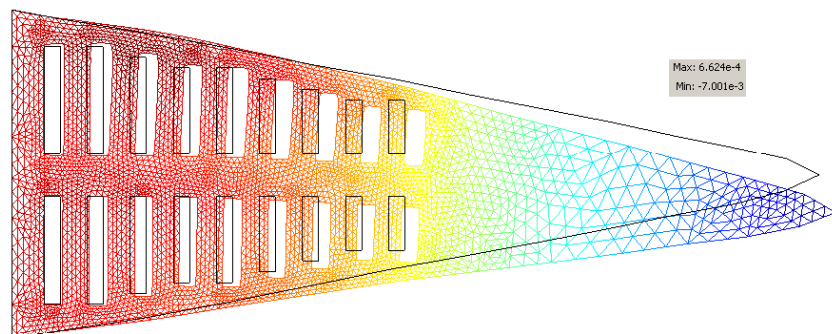




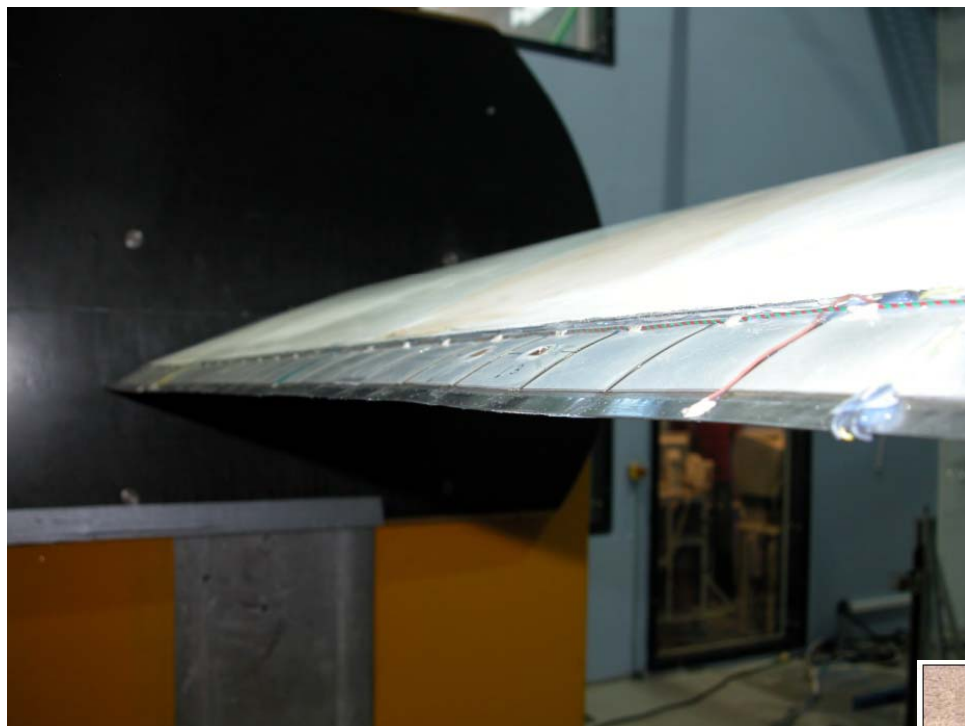
## Animated flow



# Rubber trailing edge



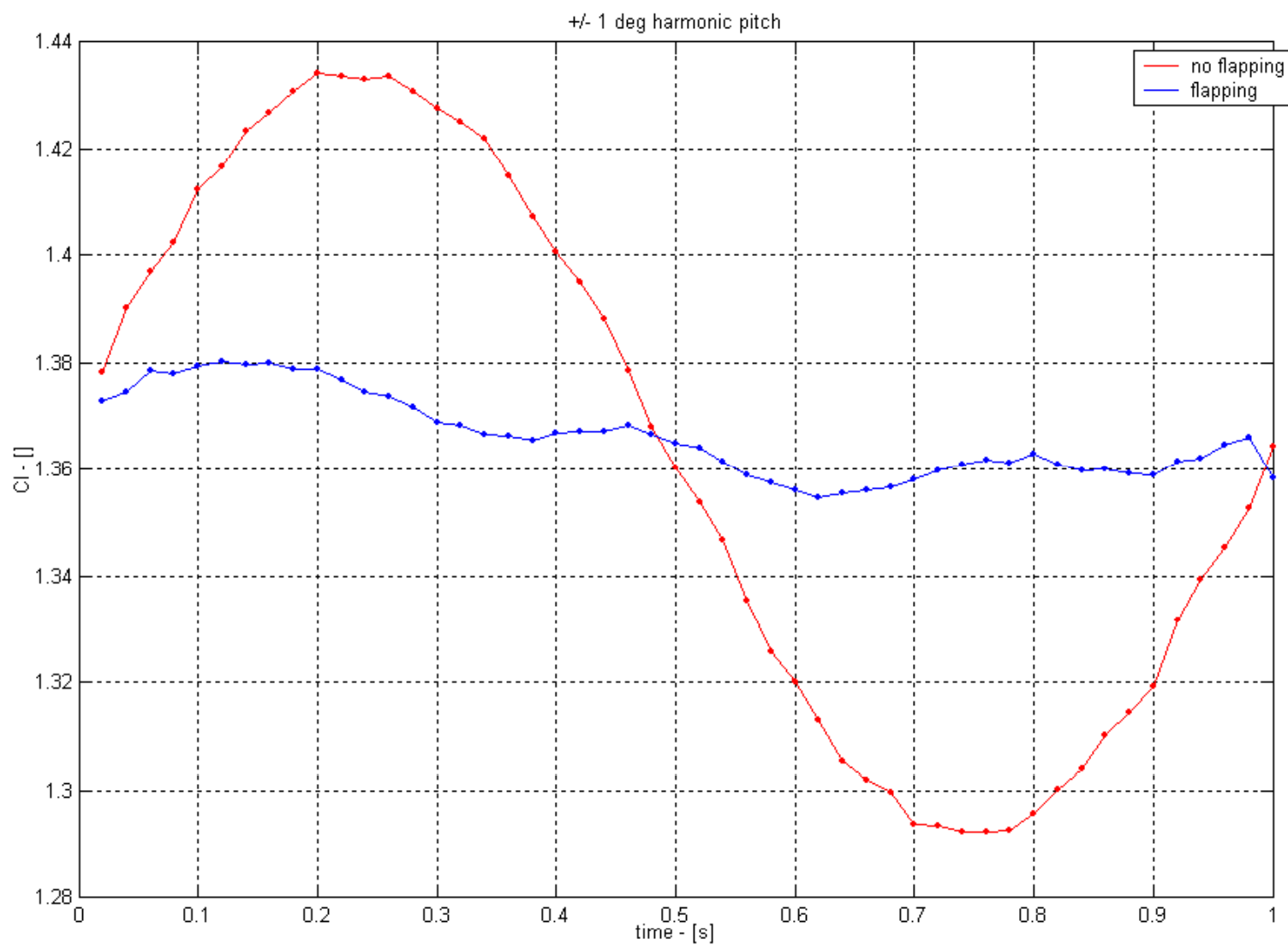
# Wind tunnel test – piezo electrical material



# Wind tunnel test



# Wind tunnel results



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# Where are the development potentials?



## Three development lines

- Incremental developments (1) (Reliability)
- Change of component and subsystem concepts (2)
- Change of wind turbine concept (3)

Research necessary basis for technology changes

